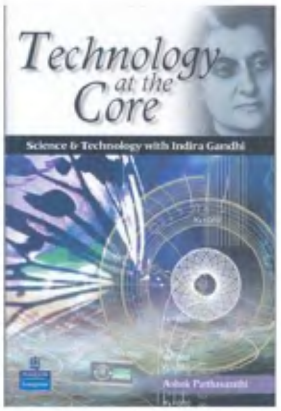


**Technology at the Core: Science and Technology with Indira Gandhi.** Ashok Parthasarathi. Darling Kindersdey (India) Pvt Ltd, Licensees of Pearson Education in South Asia, 482, F.I.E., Patparganj, Delhi 110 092. 2007. 327 pp. Price: Rs 695.

If you are interested in the nitty-gritty of how policy is made in India – especially in science and technology (S&T), and perhaps in other fields too – you must read this book. It is not so much an analysis of the processes involved, although there is some of it, but rather a series of despatches from the front line: we learn what the actors said and did, who influenced whom, what the main options were and how eventually decisions were made. It is an absorbing narrative of policy-making in the raw, so to speak.

The author, Ashok Parthasarathi, is eminently qualified to provide the narrative. After research in astrophysics at Cambridge, UK and two years spent on Science and Technology Policy at MIT, he joined the Department of Atomic Energy in 1967 accepting an invitation by its head at the time, Vikram Sarabhai. In 1970, that formidable and wise bureaucrat, P. N. Haksar persuaded Parthasarathi to join the Prime Minister's Secretariat as a Special Assistant on Science and Technology to Prime Minister Indira Gandhi, who had felt the need for an S&T 'whiz kid' to help her in making the right decisions on a variety of momentous technology policy issues that were facing her at the time. (The years 1970–75 were a special period in India's history – S&T and otherwise: it saw the Bangladesh war, establishment of the Department of Space and the 1974 nuclear test.) Parthasarathi therefore had a ring-side seat at the highest decision-making levels in the Government, and was in a position where his advice, analyses and persuasive powers could influence policy.

Although the most interesting parts of the book, at least to this reviewer, concern atomic energy, space and defence, it also touches on the work of the National Committee on Science and Technology (NCST), and policy in CSIR, agriculture, electronics and a variety of other areas. The author largely limits himself, correctly in my view, to offering a fair and readable narrative, and succeeds admirably in conveying a credible impression of the operating dynamics of the decision-making apparatus. He touches on only those issues that he encountered navigating through different positions in Government during his career spanning nearly two decades. So his account is chiefly episodic and anecdotal, but it seems carefully supported by detail presumably from his own notes. Aficionados of public decision-making will want to look up what light the book throws on issues they were involved in or on stories they have heard. Parthasarathi is to be congratulated on putting together such a fascinating, illuminating and authentic account of national decision-making that left an enduring imprint on S&T in the country for several decades.

After having read all the stories about turf battles, personal preferences and biases of leaders, virtual civil wars within S&T organizations and now-happy, now-tense interactions between scientists, bureaucrats and politicians, the reader can ask what light Parthasarathi's account throws on the big drivers of S&T policy-making in India. The answer is 'a lot', but the author (wisely perhaps) leaves it largely to the readers to draw their own conclusions.

One thing stands out from these accounts: of all the actors we encounter here, the one person who always had a big picture in mind, and was sure of where the country ought to go, was Indira Gandhi herself. She basically wanted a technologically self-reliant and strong India, and moved with great skill, determination and decisiveness towards achieving her vision. Thus she chose her bureaucrats and scientists with great care, showed them that she could be bold in action, pushed her policies with firmness, even daring, but made them understand where the red lines were. It is no wonder that her influence on India's S&T has been disproportionately large compared to the number of years she spent in office as Prime Minister.

I wish to raise two larger issues that seem to me to lurk behind the author's accounts.

The first concerns the motivations of the actors. We are an ancient and rather cynical country, and any explanation that invokes personal prejudices, rivalries, etc. will (except in the case of those accepted by the public as saintly) naturally seem the most credible to readers in general. It would of course be naïve to ignore those factors. However, popular explanations can sometimes be too facile (they explain too much), and so discourage a deeper analysis of a system's workings, and of the genuine clash of different but plausible world views that may underlie the positions assumed by some of the actors. Let me cite a few examples.

Discussing (in the very first chapter) how India did not pursue a collaborative programme with USSR on the Fast Breeder Test Reactor (FBTR) (although an agreement had already been signed), the author says (p. 23) '. . . it was a major opportunity lost . . . because of the predilections and biases of one man – Homi Bhabha!' I am sure Bhabha had his biases (like all of us) but, as the author himself remarks later, Bhabha believed that India would be able to make its own FBTR, with its own fuel. When Sarabhai took over he realized the value of collaboration, and pursued a programme with the French; there was hope in the DAE that the required fuel would be produced before long at the Madras Atomic Power Station (MAPS). However, this calculation turned out to be wide of the mark: MAPS became operational only in 1984, 18 years after Bhabha's death. So there does appear to have been an extraordinary error of judgement, involving not only Bhabha but his successors and some of his colleagues as well (with their respective biases perhaps).

As a related example, consider the internal conflict that erupted within DAE after Sarabhai's accession to the top position. Of course insider/outsider, scientist/engineer conflicts are not uncommon in S&T organizations and, as the author says, do cause terrible damage (p. 26). But then there were also serious differences of view on the directions that the Indian nuclear programme ought to pursue, especially with regard to weaponization. Amrita Shah (in *Vikram Sarabhai, A Life*, Penguin/Viking, 2007) describes how Sarabhai was first sent off to seek nuclear guarantees from the US and the European powers (he failed), and told

Robert McNamara how the international nuclear situation was beginning to unfold like a Greek tragedy (pp. 173–174). Sarabhai seemed to have had moral problems with weaponization, and this could well have exacerbated the tensions within the DAE (the Teller–Oppenheimer debates in the US regarding thermonuclear weapons come to mind). To what extent were Sarabhai's ambitious plans for nuclear energy attempts to formulate an alternative vision? And were they daring, or were they impractical? In hindsight the plans of both Bhabha and Sarabhai seem to have been most unrealistic; but then such unrealism characterized the views of many distinguished physicists elsewhere in the world too at that time – recall their predictions that power from nuclear fusion would soon be so cheap that it would not even be necessary to meter it. The euphoria of the physicists after the development of the bomb during World War II collectively blinded them to the uncertainties of technology development and acceptance. This euphoric view was eloquently codified in the famously linear plans of Vannevar Bush (in his vastly influential report to the US President entitled 'Science, the endless frontier', submitted in 1945). In collaboration with J. Srinivasan and S. K. Biswas, I have tried to describe the generally complex and tortuous path of technology development in *The Dynamics of Technology* (Sage, 2003). Or (changing tack), were there other bigger stakes involved in an unfolding and uncertain geopolitical game? Haksar hints as much after the author presents him with a thorough analysis of the economics (or dis-economics) of Indian nuclear power – the analysis is praised, but its conclusions ignored.

Again (going back to being realistic) another side of the picture is that when Sarabhai talked about the need to have foreign collaboration and emphasized commercial considerations in electronics, those in charge at the DAE were dismayed. With hindsight it would seem that Sarabhai saw the future more clearly than the rest, and was in fact being pragmatic; it is now well known that the rapid development of consumer electronics in Japan had unanticipated effects, and in particular helped usher the PC revolution by creating a mass market for electronic components that brought prices down and changed the face of electronics as a whole.

To summarize, the point I wish to make is that behind a visible clash of personalities may well lie a partially hidden clash of perceptions about the future, i.e. of world views, as well. For at least some of the issues that created tensions here were Indian versions of debates that were taking place elsewhere in the world as well – they characterized the false certainties and the unsuspected uncertainties of the age.

As a final example of a somewhat different kind, consider the way that Satish Dhawan (whose name is incidentally misspelt throughout the book with a 'v' in place of 'w'), as Chairman of the Space Commission, refused to work with defence, in particular on the *Valiant* rocket developed by DRDO (along the lines of a British design). Parthasarathi says that Dhawan took unilateral decisions on the matter, creating 'impressions with DRDL scientists that the PM's targets did not bind him' (p. 176). First of all the *Valiant*, developed for a missile, was not necessarily appropriate for the altitudes at which ISRO's launch systems would have to operate. Furthermore, it is clear that Dhawan considered it essential to maintain ISRO's civilian character beyond the faintest whiff of suspicion, and was convinced that any collaboration with DRDO would seriously jeopardize his plans for Indian space S&T development. (After all, in what the author correctly considers was a 'remarkable' letter responding to Indira Gandhi's invitation, Dhawan had already made it abundantly clear, in 1972, that he would head the space programme only if his plans were first accepted by the Government.) Indeed the later history of the *Valiant*, culminating in its eventual abandonment (because there was no demand from the armed forces), shows that ISRO's decision was not only wise but ultimately in the national interest seen from any angle, including security. (An effective missile programme in DRDO had to wait for the return of a Kalam with SLV3 experience acquired in ISRO.) The fact of the matter is that, in spite of much excellent work done in the DRDO, the defence technology ecosystem in India – including R&D, the services, and industry, all good in their own ways – is still immature (one sign of this being the never-ending arguments about the LCA, the *Arjun* tank and even the missile programme). Meanwhile, ISRO has developed into an effective technology delivery system, by policies that could not have been pursued if it were distracted by ties with defence (and, of course, thanks to many other factors that Dhawan built into the management of the space programme).

These are only three examples from a book that is replete with others that marked Indian S&T in the Indira Gandhi years.

The second issue that stands out is how certain problems in Indian S&T endure over decades: some of the discussions taking place now in the early 21st century induce a feeling of *deja vu*. Nuclear energy is one such: the virtues and the vulnerabilities associated with foreign collaboration, the problem of framing realistic targets, the imperative to preserve adequate strategic autonomy to have a reasonably independent foreign policy – remarkably, all these do not seem to have changed at all.

The situation is similar with regard to finding an appropriate organizational structure for S&T. A study team to consider the issue appointed by the Administrative Reforms Commission in the late sixties was composed of the heads of the every S&T agencies whose organizational structure had to be reviewed. So its report tended to become an assembly of chapters written by the concerned agency heads to promote whatever they considered to be in their own (or their agencies') interests. During the deliberations of the team, Sarabhai suggested a Ministry of Advanced Technologies that would bring within its fold atomic energy, space, electronics, aeronautics and earth sciences (including the oceans), each governed by a commission like the AEC. Parthasarathi says there were no takers for this sweeping proposal, and that it died instantly. However (thanks to Indira Gandhi) the Electronics Commission was indeed set up in 1971, and the Space Commission followed in 1972. The Earth Commission came up only in 2007 (I had something to do with it, but did not know about Sarabhai's proposal of 1970); the Aeronautics Commission is not in sight, although it has been vigorously debated for nearly four decades now.

However things do change as well. In two cases mentioned by Parthasarathi, namely the Indian Council of Medical Research and the India Meteorological Department (IMD), the position has indeed changed substantially during the time the book under review was being printed and published. Thanks to the present SAC-PM, there is now a Department of Health Research (set up in September

2007), and an Earth Commission and a Department of Earth Sciences (set up in January 2007), of which IMD is an important constituent.

A final example comes from the differences the author highlights between the views of the Planning Commission and NCST, the former emphasizing economic and the latter technological self-reliance. Once again I cannot help feeling that things have not changed a great deal in all these years. Haksar opposed the idea of NCST and virtually closed it down when he was made its Chairman. A National Commission on S&T (not Committee) was proposed, but did not win acceptance. It resurfaced during Rajiv Gandhi's tenure as Prime Minister, but again did not materialize. It has been revived recently, with the support of the Planning Commission – with what results we should see shortly. It is as if there are certain fundamental organizational dilemmas that the country has been unable to resolve.

There are numerous other questions that come to mind after reading Parthasarathi: his book is indeed thought-provoking. But I should stop here, saying only that the book is strongly recommended to anybody who is interested in Indian S&T, and wishes to understand how we have got to where we are today.

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**Annual Review of Pathology: Mechanisms of Disease, 2007.** Abbas, Galli and Howley (eds). Annual Reviews Inc, 4139 El Camino Way, P. O. Box 10139, Palo Alto, California 94303, USA. Vol. 2. 429 pp.

This book provides recent advances in the understanding of the disease mechanisms as well as novel experimental approaches useful to both basic scientists and physicians. While an attempt has been made by the editors to cover different types of diseases, there are five chapters dealing with different types of cancers, perhaps due to the fact that cancer is one of the most prevalent diseases.

Besides giving updates on a variety of diseases, there are two chapters devoted to upcoming areas of research. The chapter by Christopher H. Contag deals with whole-body animal imaging. With the use of *in vivo* molecular imaging of the whole animal, it is possible to study the dynamic cellular and molecular changes. Besides the description about the principle of optical imaging, specific sections on imaging using radioactive traces and optical imaging using bioluminescence and fluorescence are well described. The utility of imaging in the field of regenerative medicine and stem-cell biology is also adequately explained. The chapter by Ward and Dirks deals with cancer stem cells, one of the important and upcoming areas of biology. Cancer stem cells are a sub-population of cells in a cancer that can self-renew, differentiate and regenerate a phenocopy of the cancer when injected *in vivo*. Evidence for the presence of stem cells as early as half a century ago and the stem-cell hypothesis have been explained adequately. Successful isolation of stem cells from hematopoitic cancers and various solid tumours are well described. More importantly, the experimental and therapeutic implications of cancer stem cells are discussed. Anticancer therapies that target the bulk population of tumour cells but miss the cancer stems cells may lead to cancer recurrence and chemoresistance.

In the first chapter, Henry C. Pitot describes a model for rat hepatocarcinogenesis, the pathogenesis of neoplasia of liver. The rat model exhibits three distinct, quantifiable stages: initiation, promotion and progression. He starts with a famous quote saying that each person's life is the pattern of a mosaic and each incident happening is equal to one tiny stone in the mosaic. He narrates how his scientific life began in his grandfather's pharmacy and also about his interest to do science. Cristofano and Ellenson describe the current understanding of endometrial carcinoma, concentrating more on molecular pathways involved in the development and progression of major types of endometrial carcinoma. This is a common malignancy of the female genital track characterized by a number of tumour types. A detailed description of genetic alterations associated with two types of endometrial carcinoma (types I and II) is given. Further, the existence of endometrial stem cells and their role in carcinoma development is also discussed.

William G. Kaelin Jr illustrates the role of the *VHL* gene in the development of von Hippel–Lindau disease, which is characterized by an increased risk of hemagioblastoma, clear cell renal carcinoma and pheochromocytoma. The chapter is a good description of the structure and function of the VHL protein. Possible therapeutic strategies based on VHL biology are also discussed. Andrea I. McClatchey discusses different aspects of neurofibromatoses, which are a group of genetic disorders featuring the development of tumours of the nervous system, particularly of the nerve sheath. Differences in the genetic basis of three recognized forms of neurofibromatosis are described clearly. A good account of clinical features, pathogenesis, treatment, genetics of *NF1* and *NF2* tumour suppressor genes and mouse model of neurofibromatosis is given.

McNally and Pytel review the basic structural properties of muscle and genetic mechanisms that lead to myopathy and muscular dystrophies. The muscle structure, degeneration and regeneration, genes associated with the development of muscular dystrophy and different types of muscular dystrophies are well reviewed. Waki and Tontonoz narrate the recent advances in obesity, in particular about the adipose tissue being considered as an active endocrine organ secreting multiple bioactive factors called adipokines. Dysregulation of adipokines is emerging as an important mechanism by which the adipose tissue contributes to systemic insulin resistance and metabolic disease. In particular, detailed information is given about leptin, adiponectin, resistin, plasminogen activator inhibitor, retinol-binding protein 4, Visfatin and the role of inflammation in the adipose tissue in the development of obesity-linked insulin resistance. Wilson and Goilav focus on the mechanisms that underlie the development of human renal cystic diseases. A detailed description of inherited renal cystic diseases consisting of pattern of inheritance, gene involved, clinical features and pathology is given. Although less common, sporadic renal cystic diseases are also covered. Renal cystic diseases are characterized by the expansion of the nephron tubular epithelial components to form fluid-filled cysts lined by a single layer of epithelium. Further, a complete account of how deregulation in cellular proliferation, apoptosis, secretion, polarity and changes in cell–matrix interaction, cell–cell interactions and renal differentiation contribute to cyst expansion is provided.